

REPORT DOCUMENTATION PAGE

AFRL-SR-AR-TR-03-

Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)**2. REPORT DATE**

25 November 2003

3. REPORT TYPE AND

Final Report

4. TITLE AND SUBTITLE

Final Report for AFOSR Grant No. F49620-99-1-0059 -- "Verification and Validation of Embedded Knowledge-Based Software Systems"

5. FUNDING NUMBERSAFOSR Grant No.
F49620-99-1-0059**6. AUTHOR(S)**

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REPORT NUMBER****9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**Air Force Office of Scientific Research
4015 Wilson Blvd., Room 713
Arlington, VA 22203-1954**10. SPONSORING / MONITORING
AGENCY REPORT NUMBER****11. SUPPLEMENTARY NOTES****12a. DISTRIBUTION / AVAILABILITY STATEMENT**

Distribution Unlimited

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

20040105 074

13. ABSTRACT (Maximum 200 Words)

Our overall goal in this research effort has been to reduce the time and cost of constructing embedded knowledge-based systems that must handle uncertainty in information in a rigorous manner. Our fundamental approach actively assists subject-matter experts in organizing their knowledge inclusive of uncertainty to build such embedded systems in a consistent and correct as well as effective fashion. We pursued this by carefully examining the nature of uncertainty and information semantics and developing intelligent tools for verification and validation that provides assistance to the subject-matter expert in constructing their knowledge-based systems. We have developed a prototype environment for constructing Bayesian Knowledge-Bases called PESKI.

14. SUBJECT TERMS

Uncertainty, Bayesian Knowledge-Bases, Verification, Validation

15. NUMBER OF PAGES

4

16. PRICE CODE**17. SECURITY CLASSIFICATION
OF REPORT**

Unclassified

**18. SECURITY CLASSIFICATION
OF THIS PAGE**

Unclassified

**19. SECURITY CLASSIFICATION
OF ABSTRACT**

Unclassified

20. LIMITATION OF ABSTRACT

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AFOSR Project Final Report

Project Title: Verification and Validation of Embedded Knowledge-Based Software Systems

PI: Eugene Santos Jr., University of Connecticut

AFOSR Grant No. F49620-99-1-0059

AFOSR PM: Dr. Robert Herklotz

Final Project Summary

Our overall goal in this research effort has been to reduce the time and cost of constructing embedded knowledge-based systems that must handle uncertainty in information in a rigorous manner. Our fundamental approach actively assists subject-matter experts in organizing their knowledge inclusive of uncertainty to build such embedded systems in a consistent and correct as well as effective fashion. We pursued this by carefully examining the nature of uncertainty and information semantics and developing intelligent tools for verification and validation that provides assistance to the subject-matter expert in constructing their knowledge-based systems. We have developed a prototype environment for constructing Bayesian Knowledge-Bases called PESKI.

Major Accomplishments

- Completed formulation of Bayesian Knowledge-Bases as basis of representing uncertainty and proved it's generality through subsumption of Bayesian networks and probabilistic consistency.
- Developed a novel representation that unified probabilistic uncertainty and time.
- Defined structural incompleteness and integrated tool for managing incompleteness into PESKI.
- Developed new algorithm for reasoning under uncertainty based on randomized algorithms and reinforcement learning.
- We have developed a novel knowledge structure that can express common relationships among evidence for a conclusion via an N-of-K relation and can be constructed automatically. This relation allows the system to hide much of the structure necessary to guarantee the internal consistency of the knowledge-base. Hiding such implementation details from the expert user allows the expert to better concentrate on knowledge acquisition and validation. Our relation also captures probabilistic uncertainty in a provably correct manner.
- Formally proved the semantics of Bayesian Knowledge-Bases to provide a natural an implicit method for flexibly acquiring knowledge. By maximizing the ease with which to incorporate new knowledge in a simple if-then format while automatically maintaining consistency in the knowledge base is critical to the success of a knowledge acquisition framework.
- Finalized PESKI system for dissemination to the research community.

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Publications [7 journal articles, 1 book chapter, 16 conference papers]

[The publications below were supported in full or in part by this project.]

1. Santos, Eugene, Jr. and Santos, Eugene S., "A Framework for Building Knowledge-Bases Under Uncertainty," *Journal of Experimental and Theoretical Artificial Intelligence* 11, 265-286, 1999.
2. Santos, Eugene, Jr. and Young, Joel D., "Probabilistic Temporal Networks: A unified framework for reasoning with Time and Uncertainty," *International Journal of Approximate Reasoning* 20, 263-291, 1999.
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5. Zhong, Xiaomin and Santos, Eugene, Jr., "Probabilistic Reasoning Through Genetic Algorithms and Reinforcement Learning," Proceedings of the 12th International FLAIRS Conference, 477-481, Orlando, FL, 1999.
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16. Santos, Eunice E. and Santos, Eugene, Jr., "Effective and Efficient Caching in Genetic Algorithms," *International Journal of Artificial Intelligence Tools* 10(1-2), 273-301, 2001.
17. Lee, Jung-Jin, McCartney, Robert, and Santos, Eugene, Jr., "Learning and Predicting User Behavior for Particular Resource Use," Proceedings of the 14th International FLAIRS Conference, 177-181, Orlando, FL, 2001.
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19. Santos, Eugene, Jr., Santos, Eugene S., and Shimony, Solomon Eyal, "Semantics and Knowledge Acquisition in Bayesian Knowledge-Bases," Proceedings of the 15th International FLAIRS Conference, 524-528, Pensacola, FL, 2002.
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Proceedings of the 11th Conference on Computer Generated Forces and Behavioral Representation, 535-542, Orlando, FL, 2002.

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